IJSPT INTERNATIONAL JOURNAL OF SPORTS PHYSICAL THERAPY

Int J Sports Phys Ther. 2016 Oct; 11(5): 663–671.

PMCID: PMC5048334
PMID: 27757279

ULTRASONOGRAPHY, AN EFFECTIVE TOOL IN DIAGNOSING PLANTAR FASCIITIS: A SYSTEMATIC REVIEW OF DIAGNOSTIC TRIALS

Ahmed Radwan, PT, DPT, PhD,[1] Matthew Wyland, PT, DPT,[1] Lee Applequist, ATC, PT, DPT,[1] Erin Bolowsky, PT, DPT,[1] Heather Klingensmith, PT, DPT,[1] and Isaac Virag, PT, DPT[1]

[1]Utica College, Utica, NY, USA

Corresponding author.

CORRESPONDING AUTHOR Ahmed Radwan, PT, DPT, PhD Associate Professor, Doctor of Physical Therapy Program, Utica College, NY, USA Phone:(315) 792-3853, E-mail: aradwan@utica.edu

Abstract

Background

Plantar fasciitis (PF) is the most common cause of heel pain that affects 10% of the general population, whether living an athletic or sedentary lifestyle. The most frequent mechanism of injury is an inflammatory response that is caused by repetitive micro trauma. Many techniques are available to diagnose PF, including the use of ultrasonography (US).

Purpose

The purpose of this study is to systematically review and appraise previously published articles published between the years 2000 and 2015 that evaluated the effectiveness of using US in the process of diagnosing PF, as compared to alternative diagnostic methods.

Methods

A total of eight databases were searched to systematically review scholarly (peer reviewed) diagnostic and intervention articles pertaining to the ability of US to diagnose PF.

Results

Using specific key words the preliminary search yielded 264 articles, 10 of which were deemed relevant for inclusion in the study. Two raters independently scored each article using the 15 point modified QUADAS scale.

Discussion

Six studies compared the diagnostic efficacy of US to another diagnostic technique to diagnose PF, and four studies focused on comparing baseline assessment of plantar fascia before subsequent intervention. The most notable US outcomes measured were plantar fascia thickness, enthesopathy, and

hypoechogenicity.

Conclusion

US was found to be accurate and reliable compared to alternative reference standards like MRI in the diagnosis of PF. The general advantages of US (e.g. cost efficient, ease of administration, non-invasive, limited contraindications) make it a superior diagnostic modality in the diagnosis of PF. US should be considered in rehabilitation clinics to effectively diagnose PF and to accurately monitor improvement in the disease process following rehabilitation interventions.

Level of Evidence

1A

Keywords: plantar fascia, plantar fasciitis, ultrasound

INTRODUCTION

Plantar Fasciitis (PF) is the most common cause of heel pain, affecting 10 % of the world's general population, and over two million Americans each year.[1] It is estimated that management of PF yields an estimated annual cost of $192-376 million, adding a preventable strain to the overall costs of health care.[2]

The dysfunction and etiology of the PF is multifactorial, but most commonly it is a result of microtrauma (microtears) due to repetitive overload placed on the connective tissue in the plantar region. Over time, the microtears create structural fatigue and weakening of the connective tissue, leading to an inflammatory response, pain and discomfort. PF presents in both men and women in a relatively equivalent ratio, as well as in both athletic populations and individuals who live a more sedentary lifestyle.[1,3] Although it is more commonly seen in individuals between the ages of 40-70 years, anyone may be predisposed to develop PF due to a variety of factors including: a recent increase in running or prolonged standing activities, pes planus or pes cavus foot types, excessive tibial torsion, tightness of the gastronemius, obesity, and the use of improper footwear that is being unsupportive or alters foot kinematics.[4,5,6,7,8]

As diagnostic clinicians, physical therapists should use a variety of diagnostic tools in order to accurately diagnose PF, rule out differential diagnoses, and avoid implementing ineffective therapeutic interventions.[1] A patient history that includes an increase in physical activities, pain that is throbbing or burning, pain during toe walking, ambulating without proper footwear, and initial pain in the medial heel region, noticeable after a prolonged period of inactivity (such as upon waking up in the morning), may be indicative of PF.[1,8,9]

A clinical examination can provide valuable information to a physical therapist in order to efficiently diagnose PF. However, diagnostic imaging has been proven to be useful for further assessment of the plantar fascia structure that aids in the differential diagnosis.[1] The imaging techniques that are available are US, magnetic resonance imaging (MRI), bone scintigraphy (BS), plain radiographs, and elastography. Radiographic images have been used in cases where calcaneal bone spurs are suspected to be present. However, subcalcaneal spurs may be present in individuals with and without PF, therefore have been acknowledged to not have a direct relationship to a diagnosis of PF.[1]

Magnetic resonance imaging (MRI) has been confirmed as a reliable and validated tool to effectively diagnose PF.[10] MRI's are being used to assess and differentiate any abnormalities in the thickness of the plantar fascia. MRI, however, may be costly and time consuming and may have many precautions and contraindications that accompany the test, thereby eliminating its availability to a large

population.[1] Additionally, MR elastography utilizes same concepts of MRI and is able to visually display an image that explains the amount of stiffness in various soft tissue structures being examined.[11] Bone scintigraphy (BS) has the capacity to demonstrate an abnormal uptake of radioactive material that has collected in the bone due to a current inflammatory response.[12] Therefore, BS can be beneficial to see areas of abnormal bone growth and may be considered if symptomatic calcaneal heel spurs are suspected.[13,10]

Since the 1940's US has proven to be an excellent tool to assess musculoskeletal pathologies through the production of high quality spatial resolution sonograms, especially at the body's more superficial structures and in areas of hypoechogenicity.[14,1] Hypoechogenic areas exist where focal inflammation and diffuse tissue changes are present, thus resulting in a decreased transmission of sound waves back to the transducer head.[15] Compared to other validated and reliable tests that are capable of visually inspecting soft tissue pathology, US offers a much more cost efficient test, easier administration, a faster process to achieve the results, a non-invasive approach, better patient tolerance, and enhanced ability to display enthesopathy associated with inflammation.[1,16] Enthesopathy is visible on sonographic images at sites of muscular or tendon attachment where complete or partial ruptures may be present.[5] US images allow for assessment of plantar fascia echogenicity, thickness, complete or partial ruptures, as well as the formation of bony spurs, intrafascial calcification, perifascial fluid collection, and fascial biconvexity.[5]

The use of US is slowly becoming a more integral element of physical therapy practice, allowing for a higher standard and overall quality of care to be delivered the patient.[1] With the use of Diagnostic US, rehabilitation professionals including physical therapists can be more precise, and cost efficient with the diagnosis and treatment of PF.[17] Adapting to advancements in the physical therapy profession allows therapists to optimize evidence based practice in diagnostic imaging in order to improve the human experience to its full potential.[18] For additional information about the history of diagnostic imaging use by physical therapists and the legislative and regulatory background, the reader is encouraged to read the imaging education manual for doctor of physical therapy professional degree program that is published online through the imaging special interest group of the Orthopedic Section of the American Physical Therapy Association (APTA).

The purpose of this study is to systematically review and appraise previously published articles that evaluate the effectiveness of using diagnostic US in the process of diagnosing PF, compared to alternative diagnostic methods.

METHODS

Scholarly (peer-reviewed) diagnostic and intervention articles pertaining to the ability of US to diagnose PF published between 2000-2015 were systematically reviewed. The following databases were utilized in the search process: Medline, PubMed, CINHAL, Science Direct, Cochrane, Ovid, Sports Discuss and BioMed Central. Included articles must have been comparing US to another reference standard for diagnosing PF. Intervention studies were included if baseline assessments incorporated comparison using ultrasound to a second diagnostic method.

Two independently blinded raters performed database searches and screening of titles and abstracts, and all disagreements in their findings were resolved by a third independent rater. Results of the preliminary search revealed two hundred sixty four articles using these key words: “Plantar Fasciitis & Ultrasonography”, “Plantar Fasciitis & ultrasound”, “Plantar Fasciitis & MRI (Magnetic resonance imaging)”, “Plantar Fascia & diagnostic imaging” and “Plantar Fasciitis & imaging”. Two hundred fifty three articles were excluded, and eleven articles were deemed relevant for continuation with full text evaluation. Each of the eleven articles was assigned a quality assessment score using the 15 point

modified QUADAS from two independent blinded reviewers. A third reviewer was utilized if there were discrepancies on any of the 15 points, or the discrepancies had to be solved by raters' consensus. One last article was discarded after full text evaluation. Finally, relevant data from each of the eleven articles was then summarized into a summary table.

To assess the quality of reviewed articles, researchers used a 15 point modified QUADAS scale. The scale was adapted from table 9.1 & 9.2 in chapter 9 of the *Cochrane Handbook for Systematic Reviews of Diagnostic Test Accuracy Version 1.0.0*. Data was extracted from each article and a summary of significant information from each article was presented in a table format. The following tables summarize the results of the reviewed articles (Table 1) and color coding indicates the extent of evidence found in each of the reviewed articles according to the modified QUADAS scale (Table 2).

Table 1.

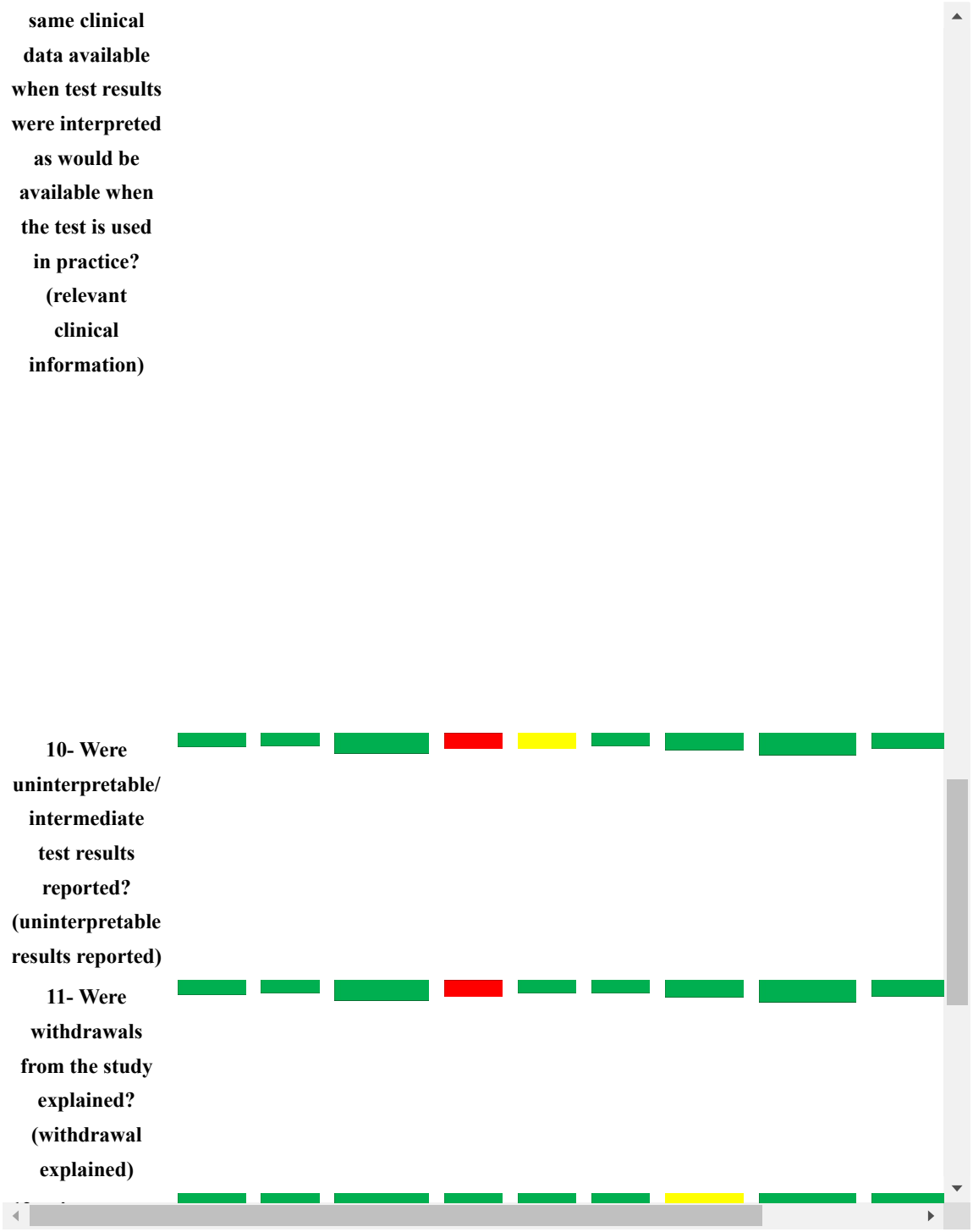
Summary table characteristics of included articles.

Authors	15-Point QUADAS Score	Sample Characteristics	Study Design	Purpose	Procedure	Outcome
Sabir et al. (2005)	14	77 symptomatic participants 11 Male 66 Female Mean Age: 45.9 ± 11.8 77asymptomatic participants 14 Male 63 Female Mean Age: 42 ± 7.5 years	Prospective study	To test the utility of sonography in the evaluation of plantar fasciitis using the MRI as a reference standard.	Ultrasound: Subjects lay prone with their feet hanging off the examination table and the ankle dorsiflexed to 90 °. Sagittal imaging of the plantar fascia.	Ultrasound successfully the followin pathologies: Enthesopath 28.9% of th Musculoapo In 7.5% of t and rupture the sample
Kapoor et al. (2010)	14	25 Participants -11 Male 14 Female Mean Age: 42 ± 3.5 with less than 2 months of bilateral heel pain	Prospective study	To evaluate the role of elastography in evaluating plantar fasciitis compared with diagnostic ultrasound and MRI.	Images were obtained in the longitudinal plane parallel to the plantar fascia by linear transducer	Findings we into three gr Grade I: Foc increased si intensity of fascia Grade Increased si intensity wi involving m 50% of the the fasica. C increased th more than 4
McMillan et al. (2012)	13	82 Participants Experimental: 19 Male 22 Female Mean Age: 51.7 ± 11.9 Control: 24 Male 17 Female	Randomized control trial	To investigate the effectiveness of ultrasound guided corticosteroid injection in the treatment of	Images were obtained where the fascia crosses the anterior aspect of the inferior calcaneal border	Clinical exa history, VAS Palpation. The experin group had a plantar fasci thickness of

Open in a separate window

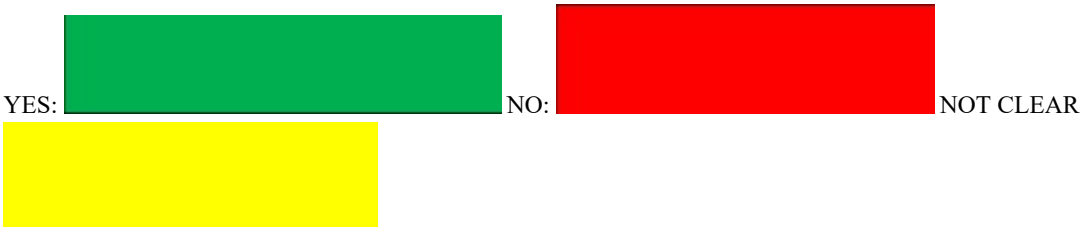
Table 2

: *Color Coded Modified 14 Point QUADAS Scores for the included articles. Adapted From Reitsma et al., The Cochrane Collaboration*



Open in a separate window

Table Color Key:



DISCUSSION

The purpose of this study was to systematically review and appraise previously published articles between the years of 2000 and 2015 that evaluate the effectiveness of using US to diagnose PF as compared with alternative diagnostic methods. Such methods ranged from clinical examination to diagnostic imaging techniques. Although there were many methodological differences among the studies, some common tendencies were revealed within the studies

Eight out of the ten included articles were identified as either randomized controlled trials or prospective comparative studies.[4,14,13,19,11,10,20,12] The age range of the participants spanned from 42 years old to 58 years old with a mean age of 50 years. A majority of the articles (9/10) included greater female representation than male, with a total of 97 males and 186 females, collectively.[4,14,13,19,11,10,20,12] Another prominent trend found throughout the articles, was that the participants were generally representative of an overweight to obese population, with a BMI ranging from 25.4 ± 3.2 to 31.4 ± 5.5.

Patient positioning during imaging was consistent between articles, with the most commonly documented position being prone with the feet hanging off of the examination table. The foot was positioned in neutral to slight dorsiflexion, diagnosing pathologies of the plantar fascia utilizing longitudinal and transverse. Multiple transducer frequencies were reported, ranging from 4-13MHZ.

Included studies consistently used a variety of similar diagnostic tools to assess and diagnose PF. Studies compared US with MRI, bone scintigraphy, elastography, and clinical examination to accurately and effectively diagnose PF. All bone scintigraphy measurements were able to visually evaluate only increased uptake in regions of increased metabolic activity. MRI based elastographic assessment was present in two out of the ten articles and was used to measure the thickness, echogenicity, stiffness, and intrafascial changes of the plantar fascia.[11,21] Significant diagnostic factors commonly referenced throughout the articles which were used as diagnostic criteria that may not have been represented by imaging modalities included the patient's apprehension of pain, the heel tenderness index (HTI), visual analog scale for pain, vascularity index (VI) and the foot function index (FFI).

During ultrasonographic assessment of the plantar fascia, the most common outcome measure utilized was the plantar fascia thickness (at site of calcaneal insertion), utilized in nine out of the total 10 articles.[4,14,21,13,19,11,10,12] Plantar fascia thickness as measured by ultrasound ranged from 4.2 ± 1.1 mm to 6.67 ± 1.53 mm for all study groups, using any thickness above 4.0 mm as a positive result. Other prevalent features assessed by the US were echogenicity, presence of bony spurs, presence of perifascial fluid, bioconvexity of the plantar fascia at its origin compared to middle and distal thirds, and vascularity of the plantar fascia.[11,21] MRI similarly assessed thickness of the fascia, as well as enthesopathy associated with ligamentous rupture.[4,11,20]

Comparison with MRI

Three studies directly compared US to magnetic resonance imaging (MRI).[4,11,20] MRI, was used as the reference standard in two studies[11,20] Sabir et al[20] reported sensitivity and specificity for US diagnosis of PF of 80.9% and 85.7%,respectively, when compared to MRI. Kapoor et al[11] reported slightly lower numbers for the sensitivity and specificity of 65% and 75%, respectively, also when compared to MRI. Two studies compared elastography to US,[11,21] three studies compared scintigraphy to US,[13,19,12] while four other authors used a clinical examination as the reference standard against US (please refer to the summary table). Common clinical examination data included; a history of inferior heel pain, first step pain, and calcaneal tenderness.

Comparison to Elastography

The use of elastography, which has a similar imaging process and results as US (however; more expensive and not as readily available), may have an advantage over US because it is able to depict early changes in tissue stiffness resulting from micro-trauma.[11] These intrafascial changes are present before inflammation and swelling of the perifascial structure are able to be seen on US, leading to elastography having a significantly higher sensitivity and specificity (98% and 83.3% respectively) for diagnosing PF in the early stages,[11] and with the progression of PF, the diagnostic value of elastography further increases to an accuracy of 96%.[11] In some cases, obvious morphologic changes may never become present in symptomatic heels, so US may not be able to depict changes in the plantar fascia thickness, whereas Elastography may be able to detect intrafascial changes in the structure which helps the early diagnosis of PF.[21]

Four out of the total ten articles reviewed were intervention articles that assessed changes in plantar fascia thickness in response to administration of treatment.[14,19,10,12] Before treatment was given, the intervention articles used baseline assessments to compare US to other diagnostic criteria. Two of the four intervention articles compared US to bone scintigraphy, while the other two compared ultrasonographic assessment to clinical examination data and a pain rating scale.[14,19,10,12] Pain rating scales correlated directly with increased thickness in plantar fascia at the calcaneal attachment site as revealed on US.[14,12] Secondarily, increased thickness and higher pain ratings correspondingly correlated with increased uptake of radioactive material as seen on bone scintigraphy.[19,10]

The results of the reviewed studies indicate a high level of agreement between the diagnostic capabilities of US to MRI, elastogrpahy, bone scintigraphy, and clinical examination. US has proven to be an effective and efficient diagnostic tool in the diagnosis of PF; however, not more effective than MRI or elastography according to the reviewed studies

Limitations and directions for future research

This systematic review was limited by the number of diagnostic studies found that met inclusion/exclusion criteria. Due to this fact, four intervention articles were included in the review that did not provide sensitivity and specificity values. Due to this limitation, the reviewed articles were not homogenous enough to complete a comprehensive quantitative analysis or meta-analysis.

CONCLUSION

US should be considered early in the process of diagnosing PF.[5] Compared to other imaging modalities, US is cost-effective, non-invasive, safe, portable, radiation-free, becoming available and easily administered.[1,17] A unique feature of US is the ability to scan dynamic structures within the body (like contracting muscle and moving tendons), which is not possible in some other forms of imaging. The ability of US to accurately diagnose PF and further assess improvements throughout the plan of care makes it a valuable tool to enhance physical therapist practice. The future direction of the

practice of physical therapy is to have a diagnostic ultrasound machine in every clinic, as well as the proper training to operate the machine and interpret the results. The common use of US will help to improve the degree of objectivity behind soft tissue clinical diagnoses that are made, thus improving the ability of a therapist to appropriately administer physical therapy interventions.[1]

REFERENCES

1. Goff JD Crawford R. Diagnosis and treatment of plantar fasciitis. Am Fam Physician. 2011;84(6):676-682. [PubMed] [Google Scholar]

2. Tong KB Furia J. Economic burden of plantar fasciitis treatment in the United States. Am J Orthop (Belle Mead, N.J.). 2010;39(5):227-231. [PubMed] [Google Scholar]

3. Schwartz EN Su J. Plantar fasciitis: a concise review. Perm J. Winter 2014;18(1):e105-107. [PMC free article] [PubMed] [Google Scholar]

4. Abdel-Wahab N Fathi S. Al-Emadi S. Mahdi S High-resolution ultrasonographic diagnosis of plantar fasciitis: A correlation of ultrasound and magnetic resonance imaging. Int J Rheum Dis. 2008;11:279-286. [Google Scholar]

5. Akfirat M Sen C Gunes T. Ultrasonographic appearance of the plantar fasciitis. J Clin Imaging Sci. 2003;27(5):353-357. [PubMed] [Google Scholar]

6. Buchbinder R. Clinical practice. Plantar fasciitis. N. Engl. J. Med. 2004;350(21):2159-2166. [PubMed] [Google Scholar]

7. Dutton M. Dutton's orthopedic examination, evaluation, and intervention 3ed: McGraw Hill; 2012. [Google Scholar]

8. Mohseni-Bandpei MA Nakhaee M Mousavi ME Shakourirad A Safari MR Vahab Kashani R. Application of ultrasound in the assessment of plantar fascia in patients with plantar fasciitis: a systematic review. Ultrasound Med Biol. 2014;40(8):1737-1754. [PubMed] [Google Scholar]

9. Martin RL Davenport TE Reischl SF, et al. Heel pain-plantar fasciitis: revision 2014. JOSPT. 2014;44(11):A1-33. [PubMed] [Google Scholar]

10. McMillan AM Landorf K. B. Gilheany M. F. Bird A. R. Morrow A. D. Menz H. B. Ultrasound guided injection of dexamethasone versus placebo for treatment of plantar fasciitis: protocol for a randomised controlled trial. J Foot Ankle Res. 2010;16(3). [PMC free article] [PubMed] [Google Scholar]

11. Kapoor A Sandhu H. S. Sandhu P. S. Kapoor A. Mahajan G. Kumar A. Realtime elastography in plantar fasciitis: comparison with ultrasonography and MRI. Curr Orthop Pract. 2010;21(6):600-608. [Google Scholar]

12. Yucel I Yazici B Degirmenci E Erdogmus B Dogan S. Comparison of ultrasound-, palpation-, and scintigraphy-guided steroid injections in the treatment of plantar fasciitis. Arch Orthop Trauma Surg. 2009;129(5):695-701. [PubMed] [Google Scholar]

13. Groshar D Alperson M. Toubi A. Gorenberg M. Liberson A. Bar-Meir E. Plantar fasciitis: detection with ultrasonography versus bone scintigraphy. J Foot 2000; 10 (3):164-168. [Google Scholar]

14. Fabrikant J Park T.. Plantar fasciitis (fasciosis) treatment outcome study: Plantar fascia thickness measured by ultrasound and correlated with patient self-reported improvement. Int J Clin Foot Sci. 2011;21(2):79-83. [PubMed] [Google Scholar]

15. Li Z Xia C. Yu A. Qi B.. Ultrasound- versus Palpation-Guided Injection of Corticosteroid for Plantar Fasciitis: A Meta-Analysis. PLoS med. 2014;9(3):1-8. [PMC free article] [PubMed] [Google Scholar]

16. McKinnis L. Fundamentals of musculoskeletal imaging. 3 ed. Philadelphia, PA: F.A. Davis Company; 2010. [Google Scholar]

17. Lee SY Park HJ Kwag HJ, et al. Ultrasound elastography in the early diagnosis of plantar fasciitis. J Clin Imaging Sci. 2014;38(5):715-718. [PubMed] [Google Scholar]

18. Association APT. Vision statement for the physical therapy profession and guiding principles to achieve the vision 2014; http://www.apta.org/Vision/. Accessed January 28th 2015.

19. Kane D Greaney T Shanahan M, et al. The role of ultrasonography in the diagnosis and management of idiopathic plantar fasciitis. Rheumatology (Oxford). 2001;40(9):1002-1008. [PubMed] [Google Scholar]

20. Sabir N Demirlenk S Yagci B Karabulut N Cubukcu S. Clinical utility of sonography in diagnosing plantar fasciitis. J Ultrasound Med. 2005;24(8):1041-1048. [PubMed] [Google Scholar]

21. Wu CH Chen WS Wang TG Lew HL. Can sonoelastography detect plantar fasciitis earlier than traditional B-mode ultrasonography? Am J Phys Med Rehabil. 2012;91(2):185. [PubMed] [Google Scholar]
